HIGHLIGHTED ARTICLES

[Multi-Regional Approach for Estimating the Economic Impact of Harvest Restrictions on Saltwater Sport Fishing](#)

North American Journal of Fisheries Management (1.201)

[Distribution and modeled transport of plastic pollution in the Great Lakes, the world's largest freshwater resource](#)

Frontiers of Environmental Science (N/A)

[2015 Vessel Activity in the Arctic](#)

NMFS Technical Memorandum (N/A)

[State space mark recapture estimates reveal a recent decline in abundance of North Atlantic right whales](#)

Ecology and Evolution (2.537)

[Projection of American dustiness in the late 21st century due to climate change](#)

Science Reports (4.259)

[Continued increase of extreme El Nino frequency long after 1.5 deg. C warming stabilization](#)

Nature Climate Change (19.304)

CROSS LINE OFFICE ARTICLES

[WMO world record lightning extremes: Longest detected flash distance and longest detected flash duration](#)

BAMS (7.929)

ADDITIONAL ARTICLES

NESDIS Publications

[Ensuring and Improving Information Quality for Earth Science Data and Products](#)
D-Lib Magazine (0.68)

NMFS Publications

[A 200-year archaeozoological record of Pacific cod (*Gadus macrocephalus*) life history as revealed through ion microprobe oxygen isotope ratios in otoliths](#)
Journal of Archaeological Science (2.196)

[Seasonal, interannual, and spatial patterns of community composition over the eastern Bering Sea shelf in cold years. Part I: zooplankton](#)
ICES Journal of Marine Science (2.760)

[The Southeast region Headboat survey: History, methodology, and data integrity](#)
Marine Fisheries Review (N/A)

[Satellite telemetry reveals higher fishing mortality rates than previously estimated, suggesting overfishing of an apex marine predator](#)
Proceedings of the Royal Society B (4.823)

[Phenological synchronization disrupts a keystone trophic interaction](#)
Proceedings of the National Academy of Sciences (9.661)

[Stable isotope analyses of feather amino acids identify penguin migration strategies at ocean basin scales](#)
Biology Letters (2.823)

[GlobalHAB: a new program to promote international research, observations, and modeling of harmful algal blooms in aquatic systems](#)
Oceanography (2.986)

Identification of *Azadinium* species and a new azaspiracid from *Azadinium poporum* in Puget Sound, Washington State, USA
Harmful Algae (2.664)

Forecasting bivalve landings with multiple regression and data mining techniques: The case of the Portuguese Artisanal Dredge Fleet
Marine Policy (2.235)

Importance of the spring transition in the northern Gulf of Mexico as inferred from marine fish biochronologies
Marine Ecology Progress Series (2.292)

Empirically based models of oceanographic and biological influences on Pacific Herring recruitment in Prince William Sound
Deep-Sea Research Part II (1.713)

Distribution patterns and population structure of the blue shark (*Prionace glauca*) in the Atlantic and Indian Oceans
Fish and Fisheries (8.258)

Natal foraging philopatry of hawksbill turtles in the eastern Pacific Ocean
Royal Society Open Science (2.89)

Evidence of diversity, site and host specificity of sea turtle blood flukes (Digenea: Schistosomatoidea: "Spirorchiidae"): A molecular prospecting study
Journal of Parasitology (3.730)

Geographic variation in Risso's dolphin echolocation click spectra
Journal of the Acoustical Society of America (1.572)
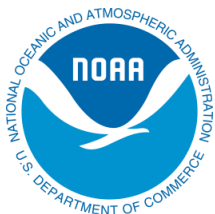
[Mapping of quantitative trait loci for temporal growth and age at maturity in coho salmon: evidence for genotype-by-sex interactions](#)
Marine Genomics (1.37)

OAR Publications

[Influence of invasive quagga mussels, phosphorus loads, and climate on spatial and temporal patterns of productivity in Lake Michigan: A biophysical modeling study](#)
Limnology and Oceanography (3.383)

[Tsunami and infragravity waves impacting Antarctic ice shelves](#)
Journal of Geophysical Research: Oceans (3.44)

[Consideration of natural sources in bacteria TMDL - lines of evidence, including beach microbial source tracking](#)
Environmental Science and Technology (6.198)

[Plasticity in skeletal characteristics of nursery-raised staghorn coral, *Acropora cervicornis*](#)
Coral Reefs (2.93)

[Contrasting patterns of connectivity among endemic and widespread fire coral species (*Millepora spp.*) in the tropical Southwestern Atlantic](#)
Coral Reefs (2.93)

HIGHLIGHTED ARTICLES

Multi-Regional Approach for Estimating the Economic Impact of Harvest Restrictions on Saltwater Sport Fishing
North American Journal of Fisheries Management (1.201)
C. Seung (NMFS/AKFSC) and **D. Lew**

- Demonstrates recruitment link between co-occurring fish species in the north Pacific
- This study overcomes the limitation of a single-region economic impact model that fails to capture the effects of a policy change occurring in the regions that are linked to the original region.
- This study considers the economic linkages between the three US regions, and shows the importance of multi-regional approaches for more accurately measuring economic impacts of changes in the bag limits, even when fishery managers may only be concerned with the economic, social, and biological effects occurring in the original region.

This study indicates that the decreases in total Alaska industry output arising from the reduced bag limits can be more than compensated for by the increases in the total output in the other two regions, depending on the assumption about how anglers who do not end up saltwater fishing spend their extra money and what metrics (quantity or value of output) are used to measure the impacts on total U.S. output. Note, however, this study did not attempt to do a full benefit-cost analysis which would consider the changes in sport anglers' welfare as well as the welfare changes resulting from the changes in industry outputs in the three US regions caused by the changes in the sport fishing-related expenditures. It is not certain whether the full benefit cost analysis would produce the result that the net benefit for the whole US increases due to the reduced bag limits.

Publication date: June 28, 2017
Available online:
http://www.tandfonline.com/doi/full/10.1080/02755947.2017.1345808

Distribution and modeled transport of plastic pollution in the Great Lakes, the world's largest freshwater resource
Frontiers of Environmental Science (N/A)
R. N. Cable, **D. Beletsky, R. Beletsky (OAR/GLERL),** K. Wigginton, B. W. Locke and M. B. Duhaime

- This study has improved our understanding of the distribution, transport, and fate of microplastics in the Great Lakes.

- Plastic pollution was documented down to the smallest size class yet reported (106-333 μm) and from this loads were estimated at nearly 2 million particles km^{-2}, the highest reported levels in the Great Lakes and possibly any surface water ecosystem.
- Microplastics pollution is an emerging issue in the Great Lakes but it is important because of it impact on lake ecosystems and human health.

Most plastic pollution originates on land. As such, freshwater bodies serve as conduits for the transport of plastic litter to the ocean. Understanding the concentrations and fluxes of plastic litter in freshwater ecosystems is critical to our understanding of the global plastic litter budget and underpins the success of future management strategies. We conducted a replicated field survey of surface plastic concentrations in four lakes in the North American Great Lakes system, the largest contiguous freshwater system on the planet. We then modeled plastic transport to resolve spatial and temporal variability of plastic distribution in one of the Great Lakes, Lake Erie. Triplicate surface samples were collected at 38 stations in mid-summer of 2014. Plastic particles >106 μm in size were quantified. Concentrations were highest near populated urban areas and their water infrastructure. In the highest concentration trawl, nearly 2 million fragments km−2 were found in the Detroit River—dwarfing previous reports of Great Lakes plastic abundances by over 4-fold. Yet, the accuracy of single trawl counts was challenged: within-station plastic abundances varied 0- to 3-fold between replicate trawls. In the smallest size class (106–1,000 μm), false positive rates of 12–24% were determined analytically for plastic vs. non-plastic, while false negative rates averaged ~18%. Though predicted to form in summer by the existing Lake Erie circulation model, our transport model did not predict a permanent surface "Lake Erie Garbage Patch" in its central basin—a trend supported by field survey data. Rather, general eastward transport with recirculation in the major basins was predicted. Further, modeled plastic residence times were drastically influenced by plastic buoyancy. Neutrally buoyant plastics—those with the same density as the ambient water—were flushed several times slower than plastics floating at the water's surface and exceeded the hydraulic residence time of the lake. It is likely that the ecosystem impacts of plastic litter persist in the Great Lakes longer than assumed based on lake flushing rates. This study furthers our understanding of plastic pollution in the Great Lakes,

a model freshwater system to study the movement of plastic from anthropogenic sources to environmental sinks.

Publication date: July 19, 2017

Available online: https://doi.org/10.3389/fenvs.2017.00045

2015 vessel activity in the Arctic

NMFS Technical Memorandum

J. Adams and **G. Silber (NMFS/HQ)**

- The rapidly warming climate and resulting reductions in sea ice extent and volume are expected to bring about changes in both the quantity and character of maritime activity in the region.
- Impacts to the Arctic's marine environment and ecosystems are likely to occur as the types and quantity of marine vessel activity increase.
- Detailed information on the quantity, spatial distribution, and seasonal variability of vessel activity in the Arctic region is provided to establish a baseline from which trends can be monitored.

The marine environment in the Arctic is changing rapidly. Continued expansion of the duration and extent of seasonal ice-free waters is projected to occur over the coming decades, resulting in new opportunities for the utilization of marine resources and increased availability of technically navigable waters. This, in turn, is projected to bring increased levels of maritime activity to the region. It is believed that this increased vessel activity will lead to the degradation of Arctic marine ecosystems, adversely impacting fish and marine mammal populations, as well as the region's indigenous people. In an effort to establish a baseline for maritime operations for Arctic waters, we analyzed satellite Automatic Identification System (AIS) data from 1 January 2015 through 31 December 2015. We quantified vessel activities using a set of metrics that includes the number of vessels, number of transits, distance traveled, hours of operation and transit density.

Our analysis of the AIS data resulted in the identification of 116,317 trips made by 5,437 individual vessels. Density analysis indicated that approximately 63% of the Arctic marine environment had been exposed to vessel traffic during 2015. For the Arctic as a whole, transits counts averaged 10,057/month, with counts ranging

from a low of 6,787 in December to 13,671 in July. Nearly half (n=51,093) of the transits were made by the 1,257 fishing vessels operating in the region. The Bulk Carrier vessel type class had one of the highest counts of unique vessels (n=1,595) operating in the Arctic during 2015, however, these vessels only accounted for less than 5% of the total transits logged in the region. While Bulk Carrier transits were relatively few in number, the distances associated with Bulk Carrier transits were some of the longest, averaging 568 nautical miles (nm). Density analysis further revealed that traffic associated with vessels in the Bulk Carrier and Dry Cargo/Passenger vessel type classes was concentrated into a limited set of well-used routes, while fishing vessels displayed a much more diffuse pattern of activity. The sea areas with the highest levels of vessel activity for 2015 were the Barentsz, Bering, and Norwegian Seas. Of the 14 oceans and seas examined, the Norwegian Sea possessed the highest transit count (n=56,952). While the majority of the transits in the Norwegian Sea belonged to fishing vessels (n=29,712), vessels in the Dry Cargo/Passenger vessel type class accounted for the highest number of operational hours (n=175,168) and distance travelled (n=3,002,488 nm) in the sea area. The Norwegian Sea also had the highest average (12.07 km/km2) and maximum (581.44 km/km2) transit densities of the 14 sea areas examined, and over 99% of the water surface area had been exposed to vessel traffic during 2015. The high level of activity in the Norwegian Sea is most likely attributable to its year round ice-free waters, proximity to population centers, and active fisheries. Despite the presence of seasonal sea ice in the Barentsz and Bering Seas, year-round, active fisheries in these sea areas also led to high levels of activity. In fact, the Barentsz Sea possessed the highest number of total operational hours (n=1,131,267), the majority of which (n=864,458) were logged by fishing vessels. Similarly, the Bering Sea possessed the highest total transit distance (n=8,106,124 nm), 39% of which was logged by fishing vessels. The Bering Sea also had the second highest maximum transit density (479.94 km/km2), attributable to the frequent use of the North Pacific Ocean Great Circle Route by bulk carrier vessels to transport goods to and from major ports in the United States and Asia. While high levels of vessel activity were maintained throughout 2015 in some of the region's sea areas, others were characterized by little to no vessel activity for the better part of 2015. For example, no vessel activity was observed in the Beaufort

Sea for 7 of the 12 months in 2015. This is most likely due to the remote location of the sea area and the fact that over 75% of the water surface area of the Beaufort Sea was covered by ice for nine of the 12 months in 2015. In total, only 483 transits were observed in the Beaufort Sea during 2015. Similar low levels of activity were observed in the Arctic Ocean, East Siberian Sea and the Northwestern Passages, where extensive ice coverage was also present for the majority of 2015. At 22.3 and 37.2%, the surface waters of the Arctic Ocean and the Northwestern Passages had the lowest exposure to vessel traffic in 2015. The above observations highlight a few of the many conclusions that can be drawn from the provided vessel activity data and are meant to guide the reader in the interpretation of the content and utility of the data. The overarching goal of this manuscript and the data contained therein is to provide a baseline of vessel activity in the Arctic to monitor trends as the marine environment of the region becomes more hospitable to vessel operations.

State space mark recapture estimates reveal a recent decline in abundance of North Atlantic right whales

R. M. Pace III, **P. J. Corkeron (NMFS/NEFSC)**, and S. D. Kraus

- North Atlantic right whales are in decline.
- Reduced survival rates of adult females relative to adult males has produced diverging abundance trends between sexes.
- The probability that the population's trajectory post-2010 was a decline was estimated at 99.99%.

North Atlantic right whales (*Eubalaena glacialis* Müller 1776) present an interesting problem for abundance and trend estimation in marine wildlife conservation. They are long-lived, individually identifiable, highly mobile, and one of the rarest of cetaceans. Individuals are annually resighted at different rates, primarily due to varying stay durations amongst several principal habitats within a large geographic range. To date, characterizations of abundance have been produced use simple accounting procedures with differing assumptions about

mortality. To better characterize changing abundance of North Atlantic right whales between 1990 and 2015, we adapted a state-space formulation with Jolly-Seber assumptions about population entry (birth and immigration) to individual resighting histories and fit it using empirical Bayes methodology. This hierarchical model included accommodation for the effect of the substantial individual capture heterogeneity. Estimates from this approach were only slightly higher than published accounting procedures, except for the most recent years (when recapture rates had declined substantially). North Atlantic right whales' abundance increased at about 2.8% per annum from median point estimates of 270 individuals in 1990 to 483 in 2010, and then declined to 2015, when the final estimate was 458 individuals (95% credible intervals 444-471). The probability that the population's trajectory post-2010 was a decline was estimated at 99.99%. Of special concern was the finding that reduced survival rates of adult females relative to adult males has produced diverging abundance trends between sexes. Despite constraints in recent years, both biological (whales' distribution changing) and logistical (fewer resources available to collect individual photo-identifications), it is still possible to detect this relatively recent, small change in the population's trajectory. This is thanks to the massive data set of individual North Atlantic right whale identifications accrued over the past three decades. Photo-identification data provide biological information that allows more informed inference on the status of this species.

Acceptance date: July 23, 2017

Available online: N/A

Projection of American dustiness in the late 21st century due to climate change
Science Reports (4.259)
B. Pu (OAR) and **P. Ginoux (OAR)**

- Using satellite observations, researchers identified the main factors influencing dust activity in the US.
- Researchers then used projected changes of these influential factors from the CMIP5 models to project dust activity in the future.
- Researchers found a close connection between dust activity and drought.

Severe dust storms have far-reaching socioeconomic impacts, affecting public transportation and health by degrading visibility, causing breathing problems and lung diseases. Dust plumes can even be continental in scale, such as the one originating in October 2012 from Nebraska and settling in the Tennessee Valley. More impressive are walls of dust (haboobs) associated with thunderstorm clouds that regularly sweep over Arizona, affecting air quality and ground transportation, as well as air traffic. Climate models project "unprecedented" dry conditions in the late 21st century over the southwestern and central U.S., regions that are co-located with major dust sources (such as the Mojave, Sonoran, and Chihuahuan deserts). However, whether dust events in the U.S. will increase in the future is not clear, as most current climate models have difficulty capturing the spatial pattern and magnitude of the dust loading in the U.S. Using satellite observations, the authors identified the main factors influencing dust activity in the U.S. They then used projected changes of these influential factors from the Coupled Model Intercomparison Project Phase 5 (CMIP5) models to project dust activity in the future. The authors found a close connection between dust activity and drought. Dust event frequency peaks during severe drought, such as the 2011 drought in the southern Great Plains, the 2012 drought centered in the central U.S., and the California droughts during 2007-2009 and 2011-2016. In addition to precipitation deficit, factors such as surface wind speeds and vegetation coverage are also related to dust emission and transport. This study shows, for the first time, how these factors influence dustiness in the U.S. About 49% to 88% of the variances of dust event frequency over the western U.S. and the Great Plains during 2004-2015 can be explained by these factors.
Publication date: July 17, 2017
Available online: https://www.nature.com/articles/s41598-017-05431-9

Continued increase of extreme El Nino frequency long after 1.5 deg. C warming stabilization
Nature Climate Change (19.304)
G. Wang, W. Cai, B. Gan, A. Santoso, X. Lin, Z. Chen, and **M. J. McPhaden (OAR - PMEL)**

- Researchers analysed climate models to demonstrate that extreme El Niño

frequency increases linearly with the GMT towards a doubling at 1.5 °C warming.

- This implies a higher risk of extreme El Niño to future generations after GMT rise has halted.
- On the other hand, whereas previous research suggests extreme La Niña events may double in frequency under the 4.5 °C warming scenario, the results presented here indicate little to no change under 1.5 °C or 2 °C warming.

The Paris Agreement aims to constrain global mean temperature (GMT) increases to 2 °C above pre-industrial levels, with an aspirational target of 1.5 °C. However, the pathway to these targets and the impacts of a 1.5 °C and 2 °C warming on extreme El Niño and La Niña events—which severely influence weather patterns, agriculture, ecosystems, public health and economies is little known. Here, by analysing climate models participating in the Climate Model Intercomparison Project's Phase 5 (CMIP5) under a most likely emission scenario we demonstrate that extreme El Niño frequency increases linearly with the GMT towards a doubling at 1.5 °C warming. This increasing frequency of extreme El Niño events continues for up to a century after GMT has stabilized, underpinned by an oceanic thermocline deepening that sustains faster warming in the eastern equatorial Pacific than the off-equatorial region. Ultimately, this implies a higher risk of extreme El Niño to future generations after GMT rise has halted. On the other hand, whereas previous research suggests extreme La Niña events may double in frequency under the 4.5 °C warming scenario, the results presented here indicate little to no change under 1.5 °C or 2 °C warming.

Publication date: July 24, 2017

Available online:

https://www.nature.com/nclimate/journal/v7/n8/full/nclimate3351.html

CROSS LINE OFFICE ARTICLES

WMO world record lightning extremes: Longest detected flash distance and longest detected flash duration
BAMS (7.929)

T. Lang, S. Pedeboy, W. Rison, R. S. Cerveny, J. Montanya, S. Chauzy, **D. MacGorman (NSSL)**, R. L. Holle, E. E. Avila, Y. Zhang, **G. Carbin (NWS)**, E. **R. Mansell (NSSL)**, Y. Kuleshov, T. C. Peterson, M. Brunet, F. Driouech, D. S. Krahenbuhl.

- Validation of new world lightning extremes demonstrates the recent and ongoing dramatic augmentations and improvements to regional lightning detection and measurement networks.
- It also provides reinforcement to lightning safety concerns that lightning can travel large distances and so lightning dangers can exist even long distances from the parent thunderstorm and important fundamental data for lightning engineering concerns.

A World Meteorological Organization weather and climate extremes committee has judged that the world's longest reported distance for a single lightning flash occurred with a horizontal distance of 321 km (199.5 mi) over Oklahoma in 2007, while the world's longest reported duration for a single lightning flash is an event that lasted continuously for 7.74 s over southern France in 2012. In addition, the committee has unanimously recommended amendment of the AMS Glossary of Meteorology definition of lightning discharge as a "series of electrical processes taking place within 1 s" by removing the phrase "within 1 s" and replacing it with "continuously." Validation of these new world extremes 1) demonstrates the recent and ongoing dramatic augmentations and improvements to regional lightning detection and measurement networks, 2) provides reinforcement regarding the dangers of lightning, and 3) provides new information for lightning engineering concerns.

Publication date: June 2017

Available online: http://journals.ametsoc.org/doi/full/10.1175/BAMS-D-16-0061.1

ADDITIONAL ARTICLES

NESDIS Publications

Ensuring and Improving Information Quality for Earth Science Data and Products
D-Lib Magazine (0.68)

- This paper provides a brief description of the efforts in various national and international agencies and programs in the area of data and information quality in general, yet with a primary focus on Earth science data.
- We formalize definitions of four aspects of information quality within the context of Earth science data product life cycle.

Information about quality is always of concern to users, whether they are buying a car or some other consumer goods, or using scientific data for research or an application. To facilitate consistent quality evaluation and description of quality information on data products for the Earth Science community, we formally introduce and define four constituents of information quality – scientific, product, stewardship, and service. As requirements to ensure and improve information quality increase across government, industry, and academia, there have been considerable efforts toward improving information quality during the last decade. Given this background, the Information Quality Cluster (IQC) of the Federation of Earth Science Information Partners (ESIP) has been active with membership from multiple organizations, participating voluntarily on a "best-effort" basis. This paper summarizes existing efforts on information quality with emphasis on Earth science data and outlines the current development and evaluation of relevant use cases. The IQC, with its open membership policy, is well positioned to bring together people from various disciplines and iteratively address the relevant challenges and needs of the Earth science data community. Moving forward, the IQC pledges to continue facilitating the development and implementation of data quality standards and best practices for the international Earth science community.
Acceptance date: July/August 2017
Available online: http://www.dlib.org/dlib/july17/ramapriyan/07ramapriyan.html

NMFS Publications

*A 200-year archaeozoological record of Pacific cod (*Gadus macrocephalus*) life history as revealed through ion microprobe oxygen isotope ratios in otoliths*
Journal of Archaeological Science (2.196)
T. Helser, **C. Kastelle (NMFS/AKFSC)**, A. Crowell, T. Ushikubo, I. J. Orland, R. Kozdon, J. W. Valley

- High resolution analyses of oxygen isotope ratios (δ18O) using secondary ion mass spectrometry of Modern and archaeological Pacific cod otoliths provide a unique perspective on biogeography and migratory behavior.
- Chronologies of δ18O from otolith core to margin reveal habitat preference for warmer near shore water during early life stage followed by a migration to cooler deeper offshore water that hasn't changed in the last 200 years.
- Near shore Gulf of Alaska temperatures, inferred through δ18O from archaeological and modern otoliths, appeared to have increased since the late Little Ice Age.

We measured δ18O values in modern and archaeological Pacific cod (*Gadus macrocephalus*) otoliths recovered from Aialik Bay on the Pacific coast of the Kenai Peninsula, Alaska using a high precision ion microprobe. Values of δ18O were measured in as many as sixty 10-micron spots along 2-3 mm transects from the otolith core to its margin with high spot-to-spot analytical precision (δ18O ±0.3‰). We obtained sample densities along a linear transect that were at least 2 to 3 times greater than micromilling/conventional mass spectrometry techniques. From modern Pacific cod otoliths (using in situ temperatures from electronic archive tags) we calibrated an empirical fractionation equation of aragonite δ18O to sea water temperature (r2 = 0.75, p<0.001, δ18OA = 2.13-0.25ToC) and from which we predicted the thermography of fish life history and historic near shore water temperature in the Gulf of Alaska. Sinuous variability of δ18O values along core-to-margin transects likely reflect seasonal temperature changes and suggest similar longevity between modern and archaeological cod. Generally increasing δ18O values from the otolith core region to the margin revealed an ontogenetic migration from warmer near shore habitat during the first year of life to cooler deeper waters at later ages, a behavior that has not changed over the past 200 years. A decline in the average δ18O of otolith cores from archaeological (~200+, ~100+ years before present) to modern otoliths suggest increasing sea surface temperatures from the late Little Ice Age to present. Temperatures calculated from the δ18O in aragonite suggest a 2-3oC rise in coastal marine sea surface temperatures in the Gulf of Alaska over the last 200 years.

Publication date: June 27, 2017

Seasonal, interannual, and spatial patterns of community composition over the eastern Bering Sea shelf in cold years. Part I: zooplankton
ICES Journal of Marine Science (2.760)

L. B Eisner, A. I. Pinchuk, **D. G. Kimmel**, **K. L. Mier**, **C. E. Harpold**, and **E. C. Siddon (NMFS/AKFSC)**

- Seasonal and spatial variations were much higher than interannual variations in zooplankton community composition.
- Models with environmental variables could explain 69-77% of zooplankton community variation within each season.
- In spring 2009 near the Alaska Peninsula, copepod stage progression was delayed and larval pollock were reduced, suggesting similar environmental factors affected both trophic levels or changes in zooplankton prey affected distributions of larval fish in this area.

Ecosystem structure and function in the eastern Bering Sea are impacted by seasonal, interannual, and spatial variation of the zooplankton community. Zooplankton abundance, community composition and individual responses of key taxa, in spring, summer, and fall were evaluated across ecoregions during three years with high sea-ice, 2008-2010 (cold years). Interannual variations were greatest in spring, but less pronounced compared to intra-annual variations. Intra-annual variations were greatest in the south middle domain in spring and the north middle domain in all seasons. Models using environmental variables were able to explain 69-77% of zooplankton community variation within each season. Among individual taxa, *Calanus marshallae/glacialis* had delayed stage progression in spring 2009 compared to 2008 and 2010 on the south middle shelf, likely due to late ice retreat and cold temperatures that increased development times. In contrast, stage progression was fastest in summer 2008 likely due to warmer temperatures. Our findings indicate that intra-annual variation of zooplankton community composition, life history stage, and abundance within a cold period may affect the amount of high–lipid zooplankton prey (e.g., Neocalanus and Calanus spp. copepods and euphausiids) available seasonally for forage fish (e.g., age-0 walleye

pollock) to grow to a sufficient size (to avoid size-dependent predation) and have sufficient lipid stores (to avoid starvation) to survive the first winter at sea.
Acceptance date: July 12, 2017
Available online: N/A

The Southeast Region Headboat Survey: History, Methodology, and Data Integrity.
Marine Fisheries Review (N/A)
E.E. Fitzpatrick (NMFS/SEFSC/BL), E.H. Williams, K.W. Shertzer, K.I. Siegfried, J.K. Craig, R.T. Cheshire, G.T. Kellison, K.E. Fitzpatrick and **K. Brennan**.

- Results indicate that the SRHS data are robust.
- The survey will continue to support stock assessments, management advice, and other studies of economically important fish species.

The Southeast Region Headboat Survey (SRHS) is administered by NMFS Beaufort Laboratory of the Southeast Fisheries Science Center. The SRHS samples recreational headboats, wherein fishermen pay by the "head" and boats typically carry more than 6 passengers. The survey has operated along the southeast U.S. Atlantic since 1972 and in the Gulf of Mexico since 1986. It is the longest continuous time series of recreational fisheries data from federal waters along the southeast coast. The SRHS data consist of trip-level logbook records submitted by captains and biological samples collected dockside by professional port agents. Our study, focused on the SRHS in southeast U.S. Atlantic, was initiated a) to document the history, protocols, and methodological changes to the SRHS, and b) to estimate the prevalence of misreporting in the survey. We recommend that our results be used to guide the filtering of logbook records containing apparently erroneous information. However, more generally, our results indicate that the SRHS data are robust. We expect the survey will continue to support stock assessments, management advice, and other studies of economically important fish species.
Acceptance date: July 18, 2017
Available online: N/A

Satellite telemetry reveals higher fishing mortality rates than previously estimated, suggesting overfishing of an apex marine predator

Proceedings of the Royal Society B (4.823)

M. E. Byrne, **E. Cortés (NMFS/SEFSC)**, J. J. Vaudo, G. C. McN. Harvey, M. Sampson, B. M. Wetherbee and M. Shivji

- Study shows that satellite tagging in general has the potential to provide accurate estimates of fishing mortality.
- Estimates of fishing mortality derived in this study were greater than those associated with maximum sustainable yield, suggesting a state of overfishing.
- Information has direct application to evaluations of stock status and for effective management of populations.

Overfishing is a primary cause of population declines for many shark species of conservation concern. However, means of obtaining information on fishery interactions and mortality, necessary for the development of successful conservation strategies, are often fishery-dependent and of questionable quality for many species of commercially exploited pelagic sharks. We used satellite telemetry as a fisheries-independent tool to document fisheries interactions, and quantify fishing mortality of the highly migratory shortfin mako shark (Isurus oxyrinchus) in the western North Atlantic Ocean. Forty satellite-tagged shortfin mako sharks tracked over 3 years entered the Exclusive Economic Zones of 19 countries and were harvested in fisheries of five countries, with 30% of tagged sharks harvested. Our tagging-derived estimates of instantaneous fishing mortality rates (F = 0.19–0.56) were 10-fold higher than previous estimates from fisheries-dependent data (approx. 0.015–0.024), suggesting data used in stock assessments may considerably underestimate fishing mortality. Additionally, our estimates of F were greater than those associated with maximum sustainable yield, suggesting a state of overfishing. This information has direct application to evaluations of stock status and for effective management of populations, and thus satellite tagging studies have potential to provide more accurate estimates of fishing mortality and survival than traditional fishery-dependent methodology.

Publication date: August 2, 2017

Available online:
http://rspb.royalsocietypublishing.org/content/284/1860/20170658

Phenological synchronization disrupts a keystone trophic interaction
Proceedings of the National Academy of Sciences (9.661)
W. W. Deacy, J. B. Armstrong, W. B. Leacock, C. T. Robbins, D. D. Gustine, **E. J. Ward (NMFS/NWFSC),** J. A. Erlenbach, J. A. Stanford

- Understanding the overlap between predators and prey is essential for understanding how changes to ecosystems affect species of interest. Some 'trophic mismatch' hypotheses have been proposed to explain shifts in timing of prey for terrestrial and marine ecosystems.
- Using a long term data set, we explored how brown bear abundance shifts locally in response to 2 key resources: salmon and elderberry. While salmon are historically thought to be more important, bears actually respond to the timing of elderberry ripening more so than salmon.
- The link between warming temperatures and earlier ripening of elderberries provides an important link between climate and trophic relationships, and understanding ways in which these environmental changes may restructure ecosystems

Climate change is altering the seasonal timing of life-cycle events in organisms across the planet, but the magnitude of change often varies among taxa. Unequal phenological responses can cause the temporal relationships among species to change, potentially altering the strength of interaction. A large body of work has explored what happens when co-evolved species shift out of sync, but virtually no studies have documented the effects of climate-induced synchronization, which could remove temporal barriers between species and create novel interactions. We explored how a keystone predator, the Kodiak brown bear (*Ursus arctos middendorffi*), responded to asymmetric phenological shifts between its primary trophic resources, sockeye salmon (*Oncorhynchus nerka*) and red elderberry (*Sambucus racemosa*). In years with anomalously high spring air temperatures, elderberry fruited several weeks earlier in the summer and became available during the period when salmon spawned in streams. In years with synchronized resource phenologies, bears left salmon spawning streams, where they typically kill 25-75%

of the salmon run, to forage on berries on adjacent hillsides. Scat surveys corroborated that bears switched from salmon to elderberries, which are less energy dense than salmon, but likely provided a mix of macronutrients that results in higher rates of weight gain. This prey switching behavior attenuated one of the most iconic predator-prey interactions in North America and certainly altered the many ecological functions and services that result from bears foraging on salmon. We provide one of the first examples of how climate-induced shifts in resource phenology can restructure food webs through a mechanism other than trophic mismatch. The current emphasis on singular consumer-resource interactions fails to capture how climate-altered phenologies are rescheduling resource availability and in turn altering how energy flows through ecosystems.
Acceptance date: July 18, 2017

Stable isotope analyses of feather amino acids identify penguin migration strategies at ocean basin scales
Biology Letters (2.823)
M. Polito, **J. Hinke (NMFS/SWFSC),** T. Hart, M. Santos, L. A. Houghton, S. R. Thorrold

- Essential amino acids $\delta^{13}C$ values in tail feathers successfully discriminated between the winter migrations strategies observed in Adélie and Chinstrap penguins.
- This approach provided more accurate classifications than bulk $\delta^{13}C$ and successfully differentiated species-specific habitat niches
- This isotopic approach enables the evaluation of migration trends at a regional scale that would be logistically challenging using direct tracking alone.

Identifying the at-sea distribution of wide ranging marine predators is critical to understanding their ecology. Advances in electronic tracking devices and intrinsic biogeochemical markers have greatly improved our ability to track animal movements on ocean-wide scales. Here we show that, in combination with direct tracking, stable carbon isotope analysis of essential amino acids in tail feathers provides the ability to track the movement patterns of two, wide-ranging penguin species over ocean basin scales. In addition, we use this isotopic approach across

multiple breeding colonies in the Scotia Arc to evaluate migration trends at a regional scale that would be logistically challenging using direct tracking alone.
Publication date: August 9, 2017
Available online: http://rsbl.royalsocietypublishing.org/content/13/8/20170241

GlobalHAB: a new program to promote international research, observations, and modeling of harmful algal blooms in aquatic systems
Oceanography (2.986)
E. Berdalet, R. Kudela, E. Urban, H. Enevoldsen, N. S. Banas, M. Burford, C. J. Gobler, B. Karlson, P. T. Lim, L. MacKenzie, M. Montresor, **V. L. Trainer (NMFS/NWFSC)**, G. Usup, and K. Yin

- GlobalHAB, 'Global Harmful Algal Blooms', is a new international scientific program on harmful algal blooms (HABs).
- GlobalHAB will promote coordinated international scientific activities, fundamental to keep progressing on the comprehension of the global complexity of HABs and contribute to the management and mitigation of their impacts worldwide.
- GlobalHAB will serve as a focal point to bring together a larger number of scientists to help address the priority questions identified as part of the program, to develop promising approaches to answering these questions, and to continue developing new questions as the field evolves.

GlobalHAB, 'Global Harmful Algal Blooms', is a new scientific program on harmful algal blooms (HABs) co-sponsored by the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the Scientific Committee on Oceanic Research (SCOR) that will operate for 10 years from 2016 to 2025. GlobalHAB builds on the solid foundation established by the former program GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms, of IOC/UNESCO and SCOR). GlobalHAB will promote coordinated international scientific activities, fundamental to keep progressing on the comprehension of the global complexity of HABs and contribute to the management and mitigation of their impacts worldwide. This general aim was recognized by the HAB science community during the GEOHAB Synthesis Open Science Meeting (OSM) in Paris, in April 2013. In this international meeting, the general design and objectives of

GlobalHAB were delineated. Following the GEOHAB OSM, the newly appointed Scientific Steering Committee of GlobalHAB elaborated the GlobalHAB Scientific and Implementation Plan, which is briefly presented in this chapter.
Publication date: March, 2017
Available online: https://doi.org/10.5670/oceanog.2017.111

Identification of Azadinium *species and a new azaspiracid from* Azadinium poporum *in Puget Sound, Washington State, USA*
Harmful Algae (2.664)
J. Kim, U. Tillmann, **N. G. Adams (NMFS/NWFSC),** B. Krock, W. L. Stutts, J. R. Deeds, M. Han, and **V. L. Trainer (NMFS/NWFSC)**

- This paper describes the identification of a new harmful algal species, *Azadinium*, and a new toxin, azaspiracid, in Puget Sound.
- Not all *Azadinium* produce the biotoxin. When isolating four species of the small dinoflagellate, *Azadinium*, only one species, *A. poporum*, consistently produced the toxin between strains.
- The risk of this toxin to human or ecosystem health is still unknown.

The identification of a new suite of toxins, called azaspiracids (AZA), as the cause of human illnesses after the consumption of shellfish from the Irish west coast in 1995, resulted in interest in understanding the global distribution of these toxins and several species of the small dinoflagellate, *Azadinium*, known to produce them. We obtained clonal isolates of four species of *Azadinium*, *A. poporum, A. cuneatum, A. obesum*, and *A. dalianense*, which were isolated from sediment samples collected from Puget Sound, Washington State in 2016. These *Azadinium* species were identified using morphological characteristics confirmed by molecular phylogeny. Whereas AZA could not be detected in any strains of *A. obesum, A. cuneatum* and *A. dalianense*, all four strains of *A. poporum* produced a new azaspiracid toxin, named AZA-59 based on LC-MS analysis. The presence of AZA-59 was confirmed at low levels *in situ* using a solid phase resin deployed at several sites along the coastlines of Puget Sound. AZA-59 is similar in structure and therefore is anticipated to have similar toxicity to AZA-37, which is 3-fold less potent than AZA-1. Using a combination of molecular methods for species

detection and solid phase resin deployment to target shellfish monitoring of toxin at high-risk sites, the risk of azaspiracid shellfish poisoning can be minimized.
Accepted date: July 19, 2017

Forecasting bivalve landings with multiple regression and data mining techniques: The case of the Portuguese Artisanal Dredge Fleet
Marine Policy (2.235)
M. M. Oliveira, A. S. Camanho, **J. B. Walden (NMFS/NEFSC),** V. L. Miguéis, N. B. Ferreira, and M. B. Gaspar

- Data mining techniques can outperform linear regression models for forecasting landings.
- Random forests as a data mining technique is particularly useful.
- Predicting landings in the presences of potential disease outbreaks is challenging.

This paper develops a decision support tool that can help fishery authorities to forecast bivalve landings for the dredge fleet accounting for several contextual conditions. These include weather conditions, phytotoxins episodes, stock-biomass indicators per species and tourism levels. Vessel characteristics and fishing effort are also taken into account for the estimation of landings. The relationship between these factors and monthly quantities landed per vessel is explored using multiple linear regression models and data mining techniques (random forests, support vector machines and neural networks). The models are specified for different regions in the Portugal mainland (Northwest, Southwest and South) using six years of data 2010–2015). Results showed that the impact of the contextual factors varies between regions and also depends on the vessels target species. The data mining techniques, namely the random forests, proved to be a robust decision support tool in this context, outperforming the predictive performance of the most popular technique used in this context, i.e. linear regression.
Publication date: July 26, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0308597X17303159

Importance of the spring transition in the northern Gulf of Mexico as inferred from marine fish biochronologies

Marine Ecology Progress Series (2.292)

M. P. Dzaugis, **R. J. Allman (NMFS/SEFSC)**, and B. A. Black

- Synchronous growth patterns were evident among red snapper, gray snapper, black drum, but not with king mackerel.
- Positive growth anomalies were associated with warm surface temperatures, southeast wind stress, and high sea level pressure in the Atlantic during early spring months.
- Spring transition is important for resident species in the northern Gulf of Mexico.

Linkages between climate variability and the productivity and functioning of Gulf of Mexico marine ecosystems remain poorly described, largely due to a lack of time series sufficiently long to establish robust bio-physical relationships. To address this issue, multidecadal biochronologies were generated from otolith growth-increment widths of red snapper *Lutjanus campechanus*, gray snapper *L. griseus*, black drum *Pogonia cromis*, and king mackerel *Scomberomorus cavalla* in the Gulf of Mexico. Synchronous growth patterns were evident among red snapper, gray snapper, and black drum, which all significantly ($p < 0.05$) correlated to one other, but not with king mackerel. Positive growth anomalies in the snapper and drum chronologies were associated with anomalously warm sea surface temperatures, southeast wind stress, and high sea level pressure in the western Atlantic during the early spring months, suggesting that an early transition from a winter to a summer climate pattern is favorable for growth. In contrast, the king mackerel chronology was dominated by decadal-scale patterns and significantly ($p < 0.01$) and negatively correlated to the Atlantic Multidecadal Oscillation. Overall, these results show the importance of the spring transition for resident species in the northern Gulf of Mexico, that growth among individuals in a migratory species can be synchronous, and that differences in life history and geography are reflected in climate−biology relationships.

Publication date: February 17, 2017

Available online: http://www.int-res.com/abstracts/meps/v565/p149-162/

Empirically based models of oceanographic and biological influences on Pacific Herring recruitment in Prince William Sound

Deep-Sea Research Part II (1.713)

F. Sewall, B. Norcross, F. Mueter, and **R. Heintz (NMFS/AKFSC)**

- Demonstrates method for improving recruitment estimates for a small pelagic fish stock in the north Pacific.
- Demonstrates recruitment link between co-occurring fish species in the north Pacific.
- The relationship has practical application to herring recruitment forecasting.

Abundances of small pelagic fish can change dramatically over time and are difficult to forecast, partially due to variable numbers of fish that annually mature and recruit to the spawning population. Recruitment strength of age-3 Pacific Herring (*Clupea pallasii*) in Prince William Sound, Alaska, is estimated in an age-structured model framework as a function of spawning stock biomass via a Ricker stock-recruitment model, and forecasted using the 10-year median recruitment estimates. However, stock size has little influence on subsequent numbers of recruits. This study evaluated the usefulness of herring recruitment models that incorporate oceanographic and biological variables. Results indicated herring recruitment estimates were significantly improved by modifying the standard Ricker model to include an index of young-of-the-year (YOY) Walleye Pollock (*Gadus chalcogrammus*) abundance. The positive relationship between herring recruits-per-spawner and YOY pollock abundance has persisted through three decades, including the herring stock crash of the early 1990s. Including sea surface temperature, primary productivity, and additional predator or competitor abundances singly or in combination did not improve model performance. We suggest that synchrony of juvenile herring and pollock survival may be caused by increased abundance of their zooplankton prey, or high juvenile pollock abundance may promote prey switching and satiation of predators. Regardless of the mechanism, the relationship has practical application to herring recruitment forecasting, and serves as an example of incorporating ecosystem components into a stock assessment model.

Publication date: July 6, 2017

Available online:

http://www.sciencedirect.com/science/article/pii/S0967064516303745?via%3Dihub

Distribution patterns and population structure of the blue shark (Prionace glauca) *in the Atlantic and Indian Oceans*

Fish and Fisheries (8.258)

R. Coelho, J. Mejuto, A. Domingo, K. Yokawa, K. Liu, **E. Cortés (NMFS/SEFSC)**, E. Romanov, C. da Silva, F. Hazin, F. Arocha, A. M. Mwilima, P. Bach, V. Ortiz de Zarate, W. Roche, P. G. Lino, B. García-Cortés, A. M. Ramos-Cartelle, R. Forselledo, F. Mas, S. Ohshimo, D. Courtney, P. S. Sabarros, B. Perez, C. Wogerbauer, W. Tsai, F. Carvalho, and M. N. Santos

- This study looked at how blue sharks, the most abundant pelagic shark species, segregate by size and sex, spatially and temporally.
- Larger blue sharks tend to occur in equatorial and tropical regions, and smaller specimens in higher latitudes in temperate waters.
- Differences in sex ratios were also detected spatially and seasonally.
- The information from this study can be used to improve the scientific advice to help adopt more informed and efficient management and conservation measures for this cosmopolitan species.

The blue shark (*Prionace glauca*) is the most frequently captured shark in pelagic oceanic fisheries, especially pelagic longlines targeting swordfish and/or tunas. As part of cooperative scientific efforts for fisheries and biological data collection, information from fishery observers, scientific projects and surveys, and from recreational fisheries from several fishing nations in the Atlantic and Indian Oceans was compiled. Datasets included information on location, size and sex, in a total of 478,220 blue shark records collected between 1966 and 2014. Sizes ranged from 36 to 394 cm fork length. Considerable variability was observed in the size distribution by region and season in both oceans. Larger blue sharks tend to occur in equatorial and tropical regions, and smaller specimens in higher latitudes in temperate waters. Differences in sex ratios were also detected spatially and seasonally. Nursery areas in the Atlantic seem to occur in the temperate southeast off South Africa and Namibia, in the southwest off southern Brazil and Uruguay,

and in the northeast off the Iberian Peninsula and the Azores. Parturition may occur in the tropical northeast off West Africa. In the Indian Ocean, nursery areas also seem to occur in temperate waters, especially in the southwest Indian Ocean off South Africa, and in the southeast off south-western Australia. The distributional patterns presented in this study provide a better understanding of how blue sharks segregate by size and sex, spatially and temporally, and improve the scientific advice to help adopt more informed and efficient management and conservation measures for this cosmopolitan species.

Publication date: July 25, 2017

Available online: http://onlinelibrary.wiley.com/doi/10.1111/faf.12238/abstract

Natal foraging philopatry of hawksbill turtles in the eastern Pacific Ocean
Royal Society Open Science (2.89)

A. R. Gaos, R. L. Lewison, **M. P. Jensen**, M. J. Liles, A. Henriquez, S. Chavarria, C. M. Pacheco, M. Valle, D. Melero, V. Gadea, E. Altamirano, P. Torres, F. Vallejo, C. Miranda, C. LeMarie, J. Lucero, K. Oceguera, D. Chácon, L. Fonseca, M. Abrego, **J. A. Seminoff**, E. E. Flores, I. Llamas, R. Donadi, B. Peña, J. P. Muñoz, D. Alarcòn Ruales, J. A. Chaves, S. Otterstrom, A. Zavala, C. E. Hart, R. Brittain, J. Alfaro-Shigueto, J. Mangel, I. L. Yañez, and **P. H. Dutton (NMFS/SWFSC)**

- Unknown movements of sea turtles during much of their life history has resulted in the theory that dispersal and development occurs in pelagic waters far from natal beaches.
- Both juvenile and adult hawksbill turtles in the eastern Pacific Ocean were found to forage near their natal beaches based on genetic data, newly coined by the authors as exhibiting natal foraging philopatry (NFP), coinciding with recent studies that found evidence that juvenile loggerhead, green, and hawksbill turtles in the Atlantic use foraging grounds in the vicinity of their natal habitats.
- NFP may be a common strategy exhibited across life stages for a number of marine turtle species and stocks with major ecological, management, and conservation implications.

The complex processes involved with animal migration have long been a subject of biological interest and broad-scale movement patterns of many marine turtle populations remain unresolved. While it is widely accepted that once marine turtles reach sexual maturity they home to natal areas for nesting or reproduction, the potential role of philopatry to natal areas across all life stages has remained largely overlooked. Here we report on genetic research that indicates that juvenile and adult hawksbill turtles (*Eretmochelys imbricata*) in the eastern Pacific Ocean use foraging grounds in the region of their natal beaches, a pattern we term natal foraging philopatry (NFP). These findings suggest that traditional views of natal homing solely for reproduction may be incomplete and that philopatry to natal areas can be a lifelong process. Our results have important implications for life-history research and conservation of hawksbills in the eastern Pacific. NFP may extend to other members of the taxon, as well as to other wide-ranging marine vertebrates that demonstrate natal philopatry.

Evidence of diversity, site and host specificity of sea turtle blood flukes (Digenea: Schistosomatoidea: "Spirorchiidae"): A molecular prospecting study

B. A. Stacy (NMFS/OPR), P. A. Chapman, A. M. Foley, E. C. Greiner, L. H. Herbst, A. B. Bolten, P. A. Klein, C. A. Manire, and E. R. Jacobson

- *Neospirorchis sp.*, blood flukes, are one of the most significant known pathogens of sea turtles, particularly in the southeastern United States.
- 92 specimens were obtained from 4 species of stranded cheloniid sea turtles, and molecular analysis was performed to identify 20 genotypes, particularly *Neospirorchis pricei*.
- This level of parasite diversity had not been recognized previously and provides the groundwork for development of better, more specific diagnostic methods and future research efforts to better understand the effects of parasitism on sea turtles.

Neospirorchis (Digenea: "Spirorchiidae") are blood flukes of sea turtles. Trematodes tentatively identified as *Neospirorchis sp.* infect various sites within sea turtles inhabiting waters of the southeastern United States, but efforts to obtain

specimens adequate for morphologic study has proven difficult. Two genetic targets, the internal transcribed spacer region of the ribosomal RNA gene and the partial mitochrondrial cytochrome c oxidase subunit I gene, were used to investigate potential diversity among parasite specimens collected from stranded sea turtles. Sequence data were obtained from 215 trematode and egg specimens collected from 92 individual free-ranging cheloniid sea turtles comprising 4 host species. Molecular analysis yielded over 20 different genotypes. We were able to assign 1 genotype to 1 of the 2 recognized species, *Neospirorchis pricei* Manter and Larson, 1950. In many examples, genotypes exhibited host and site specificity. Our findings indicate considerable diversity of parasites resembling *Neospirorchis* with evidence of a number of uncharacterized blood flukes that require additional study.
Acceptance date: July 11, 2017

Geographic variation in Risso's dolphin echolocation click spectra
Journal of the Acoustical Society of America (1.572)
M. S. Soldevilla (NMFS/SEFSC), S. Baumann-Pickering, **D. Cholewiak (NMFS/NEFSC)**, L. E. W. Hodge, **E. M. Oleson (NMFS/PIFSC)**, and **S. Rankin (NMFS/SWFSC)**
- Passive acoustic clicks were used in identifying characteristics of Risso's dolphins through the U.S. North Atlantic, Pacific, and Gulf of Mexico to determine if populations are acoustically distinct.
- The spectral peak and notch patterns between regions were compared to dolphins off southern California, and all Risso's dolphins exhibited this same pattern, useful for species identification of echolocation clicks during towed array abundance surveys and other passive acoustic studies.
- Variability in the frequencies of click spectral peaks are caused by geographic differences, supporting acoustic differentiation between stocks off Hawaii and California and between the southeast U.S. and the Gulf of Mexico.

Discrimination of bioacoustic signals to the species or population level is critical for using passive acoustic monitoring to study cetacean ecology. Risso's dolphins off southern California have distinctive peaks and notches in their echolocation

clicks, but it was unknown whether Risso's dolphins from other geographic areas have similarly distinctive click spectra and whether populations are acoustically distinct. This study investigates using clicks for species and population identification by characterizing the spectral structure of Risso's dolphin echolocation clicks recorded over wide-ranging geographic regions including the U.S. waters of the North Atlantic Ocean, Gulf of Mexico, and North Pacific Ocean; and international waters of the Eastern Tropical Pacific. All recordings with Risso's dolphin clicks exhibited the spectral peak and notch pattern described off southern California, indicating the presence of peak banding patterns is useful for species discrimination. Geographic regions were a significant explanatory factor for variability in the frequencies of click spectral peaks, with relatively higher frequency peaks and notches found off Hawaii compared to California waters and off the southeast U.S. compared to the Gulf of Mexico. In the North Atlantic Ocean, a latitudinal cline in frequencies was evident. Potential causes of acoustic variation within and among acoustic encounters are evaluated.
Acceptance date: July 5, 2017

Mapping of quantitative trait loci for temporal growth and age at maturity in coho salmon: evidence for genotype-by-sex interactions
Marine Genomics (1.37)
Miyako Kodama, **Jeffrey J. Hard (NMFS/NWFSC)**, and Kerry A. Naish

- The effects of observed Quantitative Trait Loci varied widely between males and females, indicating that growth over the course of development in coho salmon is likely to be under sex-specific genetic control.
- The study's findings provide the foundation for future efforts in localizing candidate genes shaping sex differences in life histories and exploring the adaptive significance of growth-related traits in natural fish populations.
- The genomic regions identified here should prove to be useful candidates in aquaculture breeding programs to provide accelerated genetic improvement for growth performance.

Characterizing the genetic architecture of life history traits, such the number of loci linked with the traits, the distribution of their effects and the degree of correlation helps understand the causal basis of phenotypic correlations, and contributes to an

accurate prediction of adaptive evolutionary change. In a number of salmonid species, faster growing fish in a given cohort mature earlier than conspecifics, and growth performance during spring and fall are important in determining age at sexual maturity. The aim of this study was to investigate the causal mechanisms underlying a phenotypic correlation between age at sexual maturity and growth during these periods in coho salmon, by investigating the genetic architecture of age at sexual maturity and a suite of growth-related traits. We used a genome map based on 7415 non-duplicated RAD-sequenced tags to identify 37 Quantitative trait loci (QTL) linked to these traits in a study that spanned these decision periods. Several temporally expressed growth-related QTL mapped to the same position, suggesting that these regions affected growth across many months. We also found evidence for epistatic interactions between some growth traits, and that the effect of offspring sex on QTL expression differed. One genomic region was associated with age at sexual maturity and body length and weight measured during fall when maturation was initiated, indicating that the phenotypic correlation between these traits may be due to genetic pleiotropy or co-localization of genes. Our results provide insights into the genetic architecture underlying growth-related traits in coho salmon, and have implications for understanding the genetic and evolutionary basis of phenotypic correlations among important fitness-related traits. Publication date: August 2017

OAR Publications

Influence of invasive quagga mussels, phosphorus loads, and climate on spatial and temporal patterns of productivity in Lake Michigan: A biophysical modeling study
Limnology and Oceanography (3.383)
M. D. Rowe, E. J. Anderson, H. A. Vanderploeg, S. A. Pothoven, A. K. Elgin, J. Wang (OAR/GLERL), and F. Yousef

- Quagga mussels influenced spatial and temporal distribution of chlorophyll-a. However, lake-wide, annual mean primary production was more sensitive to phosphorus and warm/cool meteorology scenarios than to mussel filter feeding scenarios.

- Our results suggest that increased nutrient loads would increase lake-wide productivity even in the presence of mussels; however, altered spatial and temporal patterns of productivity caused by mussel filter feeding would persist.

We applied a three-dimensional biophysical model to Lake Michigan for the years 2000, 2005, and 2010 to consider the mechanisms controlling spatial and temporal patterns of phytoplankton abundance (chlorophyll a) and lake-wide productivity. Model skill was assessed by comparison to satellite-derived Chl a and field-measured water quality variables. We evaluated model sensitivity to scenarios of varying mussel filter feeding intensity, tributary phosphorus loads, and warm vs. cool winter-spring climate scenarios. During the winter-spring phytoplankton bloom, spatial patterns of Chl a were controlled by variables that influenced surface mixed layer depth: deep mixing reduced net phytoplankton growth through light limitation and by exposing the full water column to mussel filter feeding. Onset of summer and winter stratification promoted higher surface Chl a initially by increasing mean light exposure and by separating the euphotic zone from mussels. During the summer stratified period, areas of relatively high Chl a were associated with coastal plumes influenced by tributary-derived nutrients and coastal upwelling-downwelling. While mussels influenced spatial and temporal distribution of Chl a, lake-wide, annual mean primary production was more sensitive to phosphorus and warm/cool meteorology scenarios than to mussel filter feeding scenarios. Although Chl a and primary production declined over the quagga mussel invasion, our results suggest that increased nutrient loads would increase lake-wide productivity even in the presence of mussels; however, altered spatial and temporal patterns of productivity caused by mussel filter feeding would likely persist.

Publication date: June 15, 2017

Available online: http://onlinelibrary.wiley.com/doi/10.1002/lno.10595/abstract

Tsunami and infragravity waves impacting Antarctic ice shelves
Journal of Geophysical Research: Oceans (3.44)

P. D. Bromirski, Z. Chen, R. A. Stephen, P. Gerstoft, **D. Arcas** (**OAR/PMEL**), A. Diez, R. C. Aster, D. A. Wiens, and A. Nyblade

- The first broadband seismometer recordings of ice shelf tsunami impacts indicate that flexural-gravity waves are the dominate response
- Very long period (>300 s) flexural-gravity waves are excited year-round, with the horizontal displacements >20 cm largest during the austral winter
- Bathymetry under and north of the RIS focuses gravity wave energy to particular locations along the front where tabular iceberg has occurred

The responses of the Ross Ice Shelf (RIS) to the 16 September 2015 8.3 (Mw) Chilean earthquake tsunami (>75 s period) and to oceanic infragravity (IG) waves (50–300 s period) were recorded by a broadband seismic array deployed on the RIS from November 2014 to November 2016. Here we show that tsunami and IG-generated signals within the RIS propagate at gravity wave speeds (~70 m/s) as water-ice coupled flexural-gravity waves. IG band signals show measureable attenuation away from the shelf front. The response of the RIS to Chilean tsunami arrivals is compared with modeled tsunami forcing to assess ice shelf flexural-gravity wave excitation by very long period (VLP; >300 s) gravity waves. Displacements across the RIS are affected by gravity wave incident direction, bathymetry under and north of the shelf, and water layer and ice shelf thicknesses. Horizontal displacements are typically about 10 times larger than vertical displacements, producing dynamical extensional motions that may facilitate expansion of existing fractures. VLP excitation is continuously observed throughout the year, with horizontal displacements highest during the austral winter with amplitudes exceeding 20 cm. Because VLP flexural-gravity waves exhibit no discernable attenuation, this energy must propagate to the grounding zone. Both IG and VLP band flexural-gravity waves excite mechanical perturbations of the RIS that likely promote tabular iceberg calving, consequently affecting ice shelf evolution. Understanding these ocean-excited mechanical interactions is important to determine their effect on ice shelf stability to reduce uncertainty in the magnitude and rate of global sea level rise.

Publication date: July 20, 2017

Available online: http://onlinelibrary.wiley.com/doi/10.1002/2017JC012913/full

Consideration of natural sources in bacteria TMDL - lines of evidence, including beach microbial source tracking

Environmental Science and Technology (6.198)

K. D. Goodwin (OAR/AOML), A. Schriewer, A. Jirik, K. Curtis, and A. Crumpacker

- Data suggested FIB exceedances could be traced to gulls based on gull marker prevalence and correlations with FIB concentrations in seawater, sand, and eelgrass.
- Human marker concentrations and a tracer dye test did not indicate prevalent human sources.
- Quantitative Microbial Risk Assessment is a suggested path forward.

Total Maximum Daily Load (TMDL) stipulations remained unmet at a southern California beach despite a suite of management actions carried out since 2001, prompting exploration of a Natural Sources Exclusion (NSE) provision within the TMDL. Quantitative Microbial Source Tracking (MST) was employed from 2012 to 2015 to inventory sources of natural and anthropogenic fecal indicator bacteria (FIB). Data suggested FIB exceedances could be traced to gulls based on gull marker prevalence and correlations with FIB concentrations in seawater, sand, and eelgrass. In contrast, human marker concentrations and a tracer dye test did not indicate prevalent human sources. Exponential decay of gull marker in sand amended with live *Catellicoccus marimammalium* suggested that measured marker reflected fecal inputs versus growth outside the host. Improved water quality was coincident with a 2013 bird exclusion structure, consistent with NSE. However, load allocation needed for TMDL reconsideration was hampered by variable ratios of FIB, MST markers, and pathogens measured in seawater and in gull, cat, and raccoon feces. Quantitative Microbial Risk Assessment is a suggested path forward because such models can incorporate distributions from a combination of FIB sources and communicate criteria in terms of human health risk.

Publication date: June 21, 2017

Available online: http://pubs.acs.org/doi/abs/10.1021/acs.est.6b05886

Plasticity in skeletal characteristics of nursery-raised staghorn coral, Acropora cervicornis

Coral Reefs (2.93)

I. B. Kuffner, E. Bartels, A. Stathakopoulos, **I. C. Enochs, G. Kolodziej**, L. T. Toth, and **D. P. Manzello (OAR/AOML)**

- This study compared staghorn coral fragments grown in coral nurseries via two rearing methods: a) attached to substratum and b) suspended in the water column.
- Coral attached to substratum had significantly higher skeletal densities and lower linear extension rates than coral suspended in water column.
- There was no significant difference between calcification rates of the two rearing methods.

Staghorn coral, *Acropora cervicornis*, is a threatened species and the primary focus of western Atlantic reef restoration efforts to date. We compared linear extension, calcification rate, and skeletal density of nursery-raised *A. cervicornis* branches reared for 6 months either on blocks attached to substratum or hanging from PVC trees in the water column. We demonstrate that branches grown on the substratum had significantly higher skeletal density, measured using computerized tomography, and lower linear extension rates compared to water-column fragments. Calcification rates determined with buoyant weighing were not statistically different between the two grow-out methods, but did vary among coral genotypes. Whereas skeletal density and extension rates were plastic traits that depended on grow-out method, calcification rate was conserved. Our results show that the two rearing methods generate the same amount of calcium carbonate skeleton but produce colonies with different skeletal characteristics and suggest that there is genetically based variability in coral calcification performance.
Publication date: March 4, 2017
Available online: https://link.springer.com/article/10.1007/s00338-017-1560-2

*Contrasting patterns of connectivity among endemic and widespread fire coral species (*Millepora spp.*) in the tropical Southwestern Atlantic*
Coral Reefs (2.93)
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- There are 4 species of fire coral found in the South Atlantic, and they provide an important ecological role as habitat builders as the only branching corals present.
- Each of the 4 species were found to form their own clade, even though 2 of the species cannot be separated through morphological characteristics.
- *M. alcicornis* is capable of long-distance dispersal, while the 3 endemic species encounter distinct biogeographic barriers due to the Amazon-Orinoco Plume and the Mid-Atlantic Barrier and more limited dispersal capabilities.

Fire corals are the only branching corals in the South Atlantic and provide an important ecological role as habitat-builders in the region. With three endemic species (*Millepora brazilensis*, *M. nitida* and *M. laboreli*) and one amphi-Atlantic species (*M. alcicornis*), fire coral diversity in the Brazilian Province rivals that of the Caribbean Province. Phylogenetic relationships and patterns of population genetic structure and diversity were investigated in all four fire coral species occurring in the Brazilian Province to understand patterns of speciation and biogeography in the genus. A total of 273 colonies from the four species were collected from 17 locations spanning their geographic ranges. Sequences from the 16S ribosomal DNA (rDNA) were used to evaluate phylogenetic relationships. Patterns in genetic diversity and connectivity were inferred by measures of molecular diversity, analyses of molecular variance, pairwise differentiation, and by spatial analyses of molecular variance. Morphometrics of the endemic species *M. braziliensis* and *M. nitida* were evaluated by discriminant function analysis; macro-morphological characters were not sufficient to distinguish the two species. Genetic analyses showed that, although they are closely related, each species forms a well-supported clade. Furthermore, the endemic species characterized a distinct biogeographic barrier: *M. braziliensis* is restricted to the north of the São Francisco River, whereas *M. nitida* occurs only to the south. *Millepora laboreli* is restricted to a single location and has low genetic diversity. In contrast, the amphi-Atlantic species *M. alcicornis* shows high genetic connectivity within the Brazilian Province, and within the Caribbean Province (including Bermuda), despite low levels of gene flow between these populations and across the tropical Atlantic. These patterns reflect the importance of the Amazon–Orinoco Plume and the Mid-

Atlantic Barrier as biogeographic barriers, and suggest that, while *M. alcicornis* is capable of long-distance dispersal, the three endemics have restricted ranges and more limited dispersal capabilities.

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